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XLV. *An eaſy Method of making a Phoſphorus, that will imbibe and emit Light, like the* Bolognian *Stone; with Experiments and Obſervations; by* John Canton, *M. A. and F. R. S.*

To make the PHOSPHORUS.

Read December 22, 1768.

CALCINE ſome common oyſter ſhells, by keeping them in a good coal fire for half an hour; let the pureſt part of the calx be pulverized, and ſifted; mix with three parts of this powder one part of the flowers of ſulphur; let this mixture be rammed into a crucible of about an inch and a half in depth, till it be almoſt full; and let it be placed in the middle of the fire, where it muſt be kept red hot for one hour at leaſt, and then ſet by to cool: when cold, turn it out of the crucible, and cutting, or breaking it to pieces, ſcrape off, upon trial, the brighteſt parts; which, if good phoſphorus, will be a white powder; and may be preſerved by keeping it in a dry phial with a ground ſtopple.

The quantity of light a little of this phoſphorus gives, when firſt brought into a dark room, after it has been expoſed for a few ſeconds, on the outſide of a window to the common light of the day, is ſufficient to diſcover the time by a watch, if the eyes

have been ſhut, or in the dark, for two or three minutes before.

By this phoſphorus celeſtial objects may be very well repreſented; as Saturn and his ring, the phaſes of the Moon, &c. if the figures of them, made of wood, be wetted with the white of an egg, and then covered with the phoſphorus. And theſe figures appear to be as ſtrongly illuminated in the night, by the flaſh from a near diſcharge of an electrified bottle, as by the light of the day.

Experiment I.

Having put ſome of the ſame parcel of the phoſphorus into two glaſs balls, and ſealed them hermetically; I placed one of them on the outſide of a window facing the South, that it might be very much expoſed to the direct rays of the Sun, where it remained from the 25th of December 1764, to the 25th of December 1765. The other was kept during the ſame time in darkneſs. After this, they were both expoſed to the light, and carried into a dark room together; where the phoſphorus in each appeared equally bright.

Experiment II.

Some of the phoſphorus finely powdered, being put into a glaſs ball, with as much water as would make it adhere to the glaſs, ſo as to cover the inſide of the ball, which was hermetically ſealed, was found gradually to loſe its property of imbibing and emitting light, but faſter in ſummer than in winter; ſo that at

at the end of the firſt year, it could not, in the leaſt, be perceived to ſhine, when taken from the ſtrongeſt day-light, and carried into a dark room. It was alſo obſerved to loſe its whiteneſs by degrees, and to become of a very dark colour, eſpecially on that ſide of it next to the glaſs. Some of the phoſphorus which was made to ſtick to the inſide of a glaſs ball hermetically ſealed, by means of common ſpirit of wine, was found after one year to be a little impaired; but ſome made to ſtick by means of an ætherial ſpirit, was found not to be impaired at all.

According to Doctor Nicholas Lemery (in his Courſe of chymiſtry, eleventh edition) the expoſing the Bolognian ſtone to the Sun wears it out. But by the firſt experiment it appears, that a phoſphorus of the ſame kind was not hurt by the Sun in twelve months. Water, indeed, in the ſecond experiment, was found in that time to deſtroy it. Therefore it is probable, that what the Doctor imputed to the light of the Sun, was cauſed by the moiſture of the air.

Experiment III.

I mixed a ſmall quantity of the phoſphorus with a conſiderable quantity of ſpirit of wine in one glaſs ball, and with æther in another, and ſealed them hermetically. When the balls were ſhook, each of the fluids appeared like milk; but the phoſphorus would ſoon ſubſide when the balls were at reſt, and leave the ſpirit of wine and æther quite clear. After ſome months, the ſpirit of wine was found to be tinged with yellow; but the æther, to this time, remains unaltered. By ſhaking the balls while they are expoſed

to the light, the whole of the fluid in each, will appear luminous when carried into a dark room. The æther gives as much light now, as it did at firſt; but the ſpirit of wine a little leſs.

Experiment IV.

I expoſed the dry phoſphorus, in one of the glaſs balls mentioned in the firſt experiment, to the light of the day, by holding it on the outſide of a North window about half a minute; after which it was kept in darkneſs for two days and a half, and was then found to ſhine, by putting the glaſs ball that contained it into a baſon of boiling water. On the morrow it was expoſed to the light again; and after it had been kept four days and a half in the dark, it gave light when put into boiling water, though not ſo much as before. In ſummer, I find, it will not give any light by the heat of boiling water after keeping it fifteen days; but in winter, it will afford a little, after keeping it a month.

Experiment V.

The phoſphorus in each of the two glaſs balls mentioned in the firſt experiment was illuminated at the ſame time and to the ſame degree, and carried into a dark room. One of the balls was immediately put into a baſon of boiling water, and thereupon the phoſphorus in it became much brighter than that in the other, and continued ſo for a ſhort time, but parted with its light ſo faſt, that in leſs than ten minutes it was quite dark. The other phoſphorus ſtill gave a conſiderable degree

degree of light, and remained viſible for more than two hours after, when even the heat of the hand would plainly increaſe its light.

Bolognian phoſphorus is ſaid, by Lemery, and alſo by Muſſchenbroek *, to imbibe leſs light when hot than when cold, as it appears leſs bright when carried into a dark room. But this appearance may be cauſed by its parting with the light it has received faſter when in the former ſtate, than when in the latter, according to the laſt experiment; as it muſt loſe more when hot, than when cold, during the time of conveying it from the place where it takes the light, to a place dark enough to obſerve it in. And this ſeems to be the cauſe alſo, why Bolognian phoſphorus never appears ſo bright after it has been illuminated, and conſequently in ſome meaſure heated, by the direct beams of the Sun, as after it has only been expoſed, in the ſhaded open air, to the common light of the day.

Experiment VI.

The balls uſed in the laſt experiment were kept in the dark for two days after, and then each at the ſame time was put into a baſon of boiling water in a dark room: that which had parted with its light in the hot water before, was not viſible; but the other appeared luminous for a conſiderable time.

When the phoſphorus has once loſt as much of the light it had received, as the heat of boiling water will

* See his *Introductio ad Philoſophiam Naturalem*, § 1697. See alſo § 1704 and 1686.

cauſe

cauſe it to part with, it has never after been found, if kept in darkneſs, to give any more light by that degree of heat. But if it be expoſed again to the common light of the day, the experiments may be repeated with the ſame ſucceſs as before. This has frequently been done, with ſome dry phoſphorus in glaſs balls which have been hermetically ſealed about four years, without the leaſt injury to the phoſphorus; as it appears to be as good now as it was at firſt.

Experiment VII.

Let one end of a bar of iron of about an inch ſquare, or a poker, be made red hot, and laid horizontally in a darkened room, till by cooling it ceaſes to ſhine, or is but barely viſible. Then bring a little dry phoſphorus, which has been expoſed to light in a glaſs ball hermetically ſealed, as near the hot iron as poſſible, by holding the ball in contact with it; and the phoſphorus, though inviſible before, will in a few ſeconds begin to ſhine; and will diſcharge its light ſo very faſt as to be entirely exhauſted of it in leſs than a minute; and then will ſhine no more by the ſame treatment, till after it has been expoſed to light again. By this heat, light received from a candle, or even from the Moon, may be ſeen ſeveral days after. And phoſphorus that will afford no more light by the heat of boiling water, will ſhine again by the heat of the iron. By this heat alſo, phoſphorus which had been kept in darkneſs more than ſix months, was found to give a conſiderable degree of light.

It was the opinion of the great Sir Iſaac Newton, that the rays of light are very ſmall bodies emitted from

from ſhining ſubſtances, and not motion propagated through a fluid medium; for ſeveral reaſons which he has given in his Opticks. Notwithſtanding which, it has been urged ſince his time, that light is nothing but a repellent fluid put into very violent vibrations. Now it appears impoſſible, to me, at leaſt, if light be nothing but motion propagated through a fluid medium, and not particles emitted from the luminous body, to account for the phænomena in the fifth, ſixth, and ſeventh experiments. That a ſubſtance ſhould either give light or not, when its parts are agitated by the ſame degree of heat, according as it has, or has not been expoſed to light, for a few ſeconds of time, more than ſix months before; ſeems plainly to indicate a ſtrong attraction between that ſubſtance and the particles of light; by which it keeps many of them, in the common heat of the air, a long time, if not always: for the light the phoſphorus gives by being heated to a certain degree appears to be cauſed by its throwing off adventitious particles, and not by any of its own; ſince its light will decreaſe and be entirely gone, before the phoſphorus will be hot enough to ſhine of itſelf, or to emit particles of light from its own body.

A writer againſt the Newtonian doctrine of light is preſſed with a great difficulty, and aſks, if it be poſſible that a particle can move ſo far as from the Sun to the Earth, and not frequently impinge upon other particles, when, he ſays, every part of ſpace muſt contain thouſands of them? But this difficulty will nearly vaniſh, if a very ſmall portion of time be allowed, between the emiſſion of every particle and the

the next following in the ſame direction. Suppoſe, for inſtance, a lucid point of the Sun's ſurface to emit 150 particles in one ſecond, which are more than ſufficient to give continual light to the eye, without the leaſt appearance of intermiſſion; and then the particles, on account of their great velocity, will be behind one another more than 1000 miles, and leave room enough for others to paſs, in all directions.

XLVI. *Aſtrono-*